Response of microzooplankton to iron-induced phytoplankton blooms in the Southern Ocean

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Introduction

Mesoscale *in situ* iron fertilisation experiments have resulted in the build-up of phytoplankton biomass and established beyond doubt that iron availability is the key factor limiting growth rates of oceanic phytoplankton in "high-nutrient, low-chlorophyll" (HNLC) regimes (see poster Assmy *et al.*). The response of microzooplankton groups (aplastidic dinoflagellates, aloricate and tintinnid ciliates) of the pelagic community and the processes within the pelagic food web (Fig. 1) were studied in detail and compared with processes in the surrounding water during two Southern Ocean iron fertilisation experiments conducted in austral spring (EisenEx) and in late summer early fall (EIFEX). Species abundance, biomass and taxonomic composition were quantified by microscopic techniques from sedimented water samples taken from the mixed surface layer.

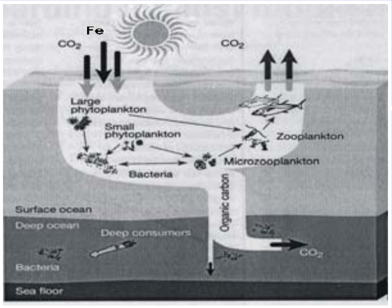

Fig. 1: The complex phytoplankton-based food web (Fig. modified from a graphic by Z. Johnson)

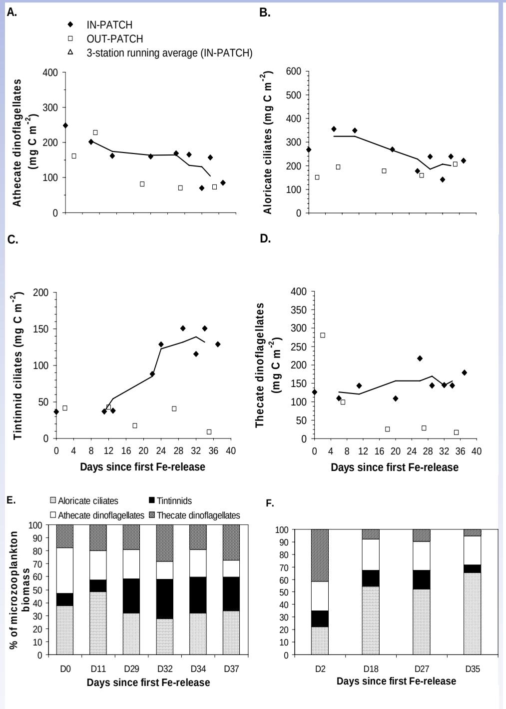

Fig. 2: Temporal development of A) athecate dinoflagellate, B) aloricate ciliate, C) tintinnid and D) thecate dinoflagellate biomass during EIFEX integrated over 100 m mixed layer depth. Composition of microzooplankton E) inside the fertilised patch and F) in unfertilised waters.

Results and Discussion

By the peak of the experiments, phytoplankton carbon stocks had increased 3fold (EIFEX) and 4fold (EisenEx), respectively, whereas the microzooplankton groups showed different trends inside the fertilised patch. Copepod grazing apparently had a significant impact on their temporal development: Aplastidic dinoflagellates, one of the dominant micrograzers (Figs. 2E and F; 3E and F) and comprising athecate and thecate forms, either decreased from the beginning (EIFEX; Figs. 2A, 2D) or significantly increased in biomass in the first 10 d of the experiment, but decreased thereafter to values 2fold higher than pre-fertilisation values (EisenEx; Fig. 3A, 3D) indicating heavy grazing mortality mainly by metazoan predators. They also constrained ciliate carbon stocks which either decreased during EIFEX (Fig. 2B) or stayed more or less constant during EisenEx (Figs. 3B, 3C). Bottle incubation conducted during EisenEx suggest that aloricate ciliates increased growth rates (from 0.23 to 0.41 d^{-1}) with higher food availability but grazing pressure on them also intensified so that no net growth was recorded. However, tintinnid biomass increased 3.5fold during EIFEX (Fig. 2C) and constituted an important component at the end of the experiment clearly showing a release of grazing pressure probably due to an intensification of grazing impact on other microzooplankton groups.

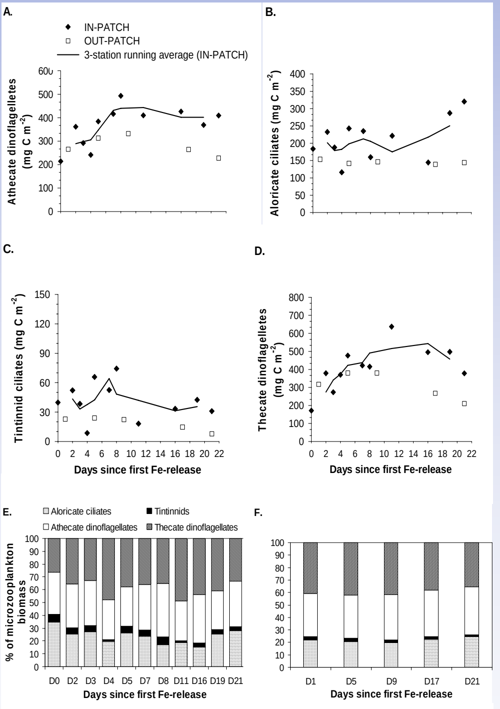

Fig. 3: Temporal development of A) athecate dinoflagellate B) aloricate ciliate, C) ciliate and D) thecate dinoflagellate biomass during EisenEx integrated over 80 m mixed layer depth. Composition of microzooplankton E) inside the fertilised patch and F) in unfertilised waters.

Conclusions

• The changes in the dynamics and structure within the microzooplankton during the experiments suggest that their grazing constrained pico- and nanoplankton populations, but mainly species capable of feeding on large diatoms were selectively predated by the metazoan community.

→ Tight coupling between prey and predators regulated population dynamics and facilitated population growth of diatoms (trophic cascade) which dominated the iron-induced phytoplankton bloom.